



U.S. Army Research, Development and Engineering Command

# *The Validation and Approval of Chemical Agent Resistant Coatings*



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

ASETSDefense 2012: Sustainable Surface Engineering for  
Aerospace and Defense

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- Who We Are & What we Do
- Standardization & Specifications
- Technical Challenges
- Selected CARC Efforts and discussions
- Final Thoughts



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

- **ARL is the Lead DOD R&D Activity for CARC**
  - Innovative formulations approaches
  - New raw materials selections
  - Advanced characterization
- **Maintains Ownership for all key specifications regarding pretreatments, primers and topcoats for all tactical and related support equipment and munition coatings.**

- ❖ *Elements above assist to implement and transition products to the field.*

- **Develop materials for military unique coatings including pretreatments, primers, and topcoats**
  - Chemical Agent Resistant Coatings
  - Munitions coatings
  - Industrial coatings for vehicle interiors
- **Implement and transition new products**
  - Specifications and Standards
  - Troubleshooting, consulting, and problem solving
- **Analyze and solve technical problems related to coatings systems used on Army Materiel**

## Implementation

Environmental

Survivability



Durability

- Every item that the Army fields starts with a document, namely a specification. Multiple specifications may be required to define a specific item along with a standard on how to process the item.
  - Cleaning Methods
  - Pretreatment Methods
  - Anticorrosive Primers
  - Chemical Agent Resistant Coating (CARC) Topcoat

**Governed by application and inspection specification,  
MIL-DTL-53072.**

- Step 1 – Planning
- Step 2 – Research & Development
- Step 3 – Approval and Publication
  
- Reasons for development or revision of specifications:
  - Environmental regulations (Hexavalent Chromate and HAPs)
  - Performance requirements
  - Advances in new technology
  - **Major gaps in technology**
  
- Uniqueness of Coating and Corrosion Team Specifications:
  - Notarized Statements of Composition
  
- Transition document for military to use in contracts

## Hierarchical Architecture of Multifunctional Coatings

### Today

**CARC Camouflage  
Polyurethane Topcoat  
(1.8 mil)**

- Visible and NIR
- Silica extender
- Semitransparent binders

**CARC epoxy primer  
(0.8 - 1.2 mils)**

**Chemical Conversion  
Coating (0.2-0.3 mil)**

**Substrate  
(ferrous or nonferrous)**

### Tomorrow

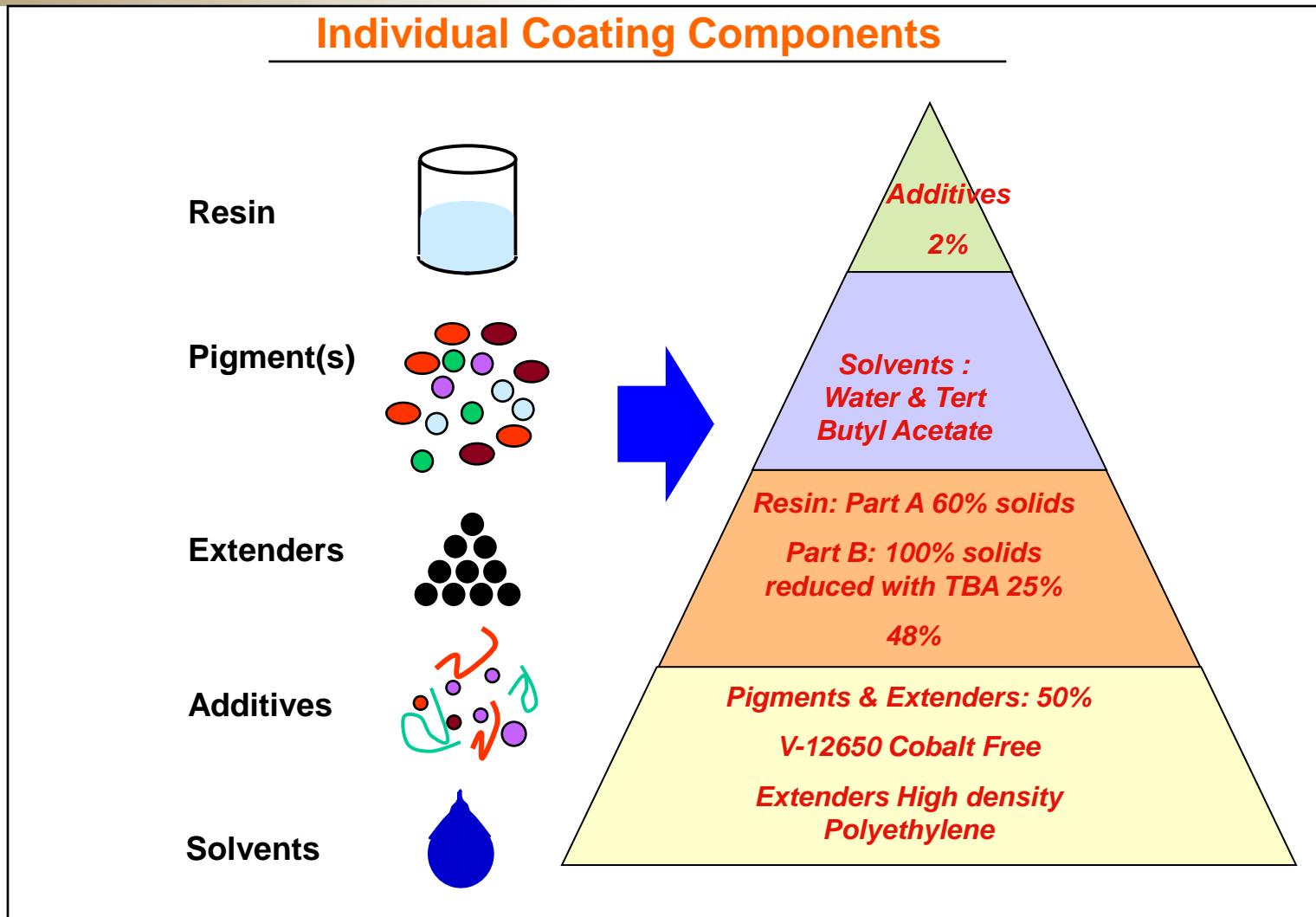
**Tailored CARC Coating**

- Functional pigmentation
- Controlled Roughness

**Functional Primer**  
•Corrosion Protection  
•Texture

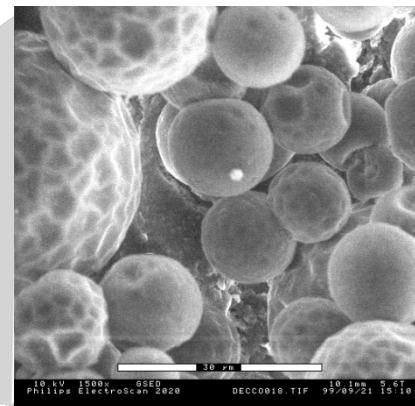
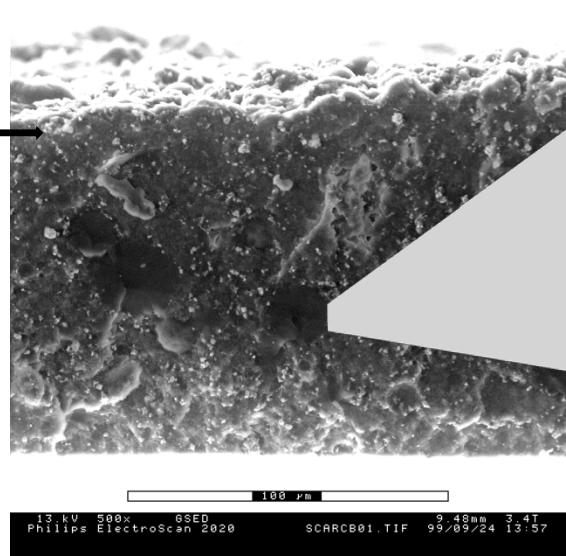
**Advanced Corrosion  
Protection Layer**

**Substrate**  
•Ferrous  
•Nonferrous  
•Polymer Composite



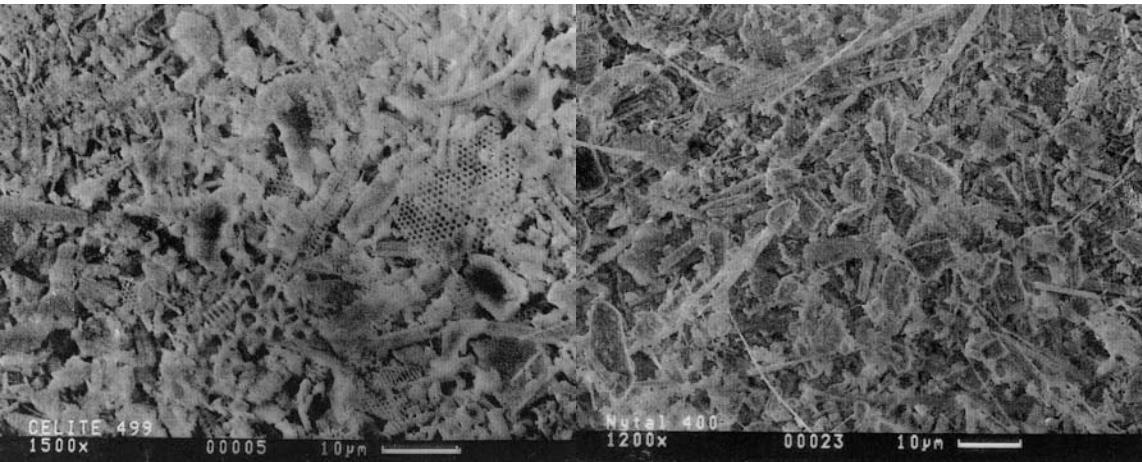
- Hexavalent Chromium Free Pretreatments for various substrates.\*
- Alternatives to Isocyanate Based Topcoats\*
- Elimination of Silica Flattened topcoats
- New Chemical Agent Testing Methodologies
- Alternatives to conventional cure

Polymeric beads →  
Army will  
Discontinue use  
of Silica based  
topcoats



- **Integrated within Film**

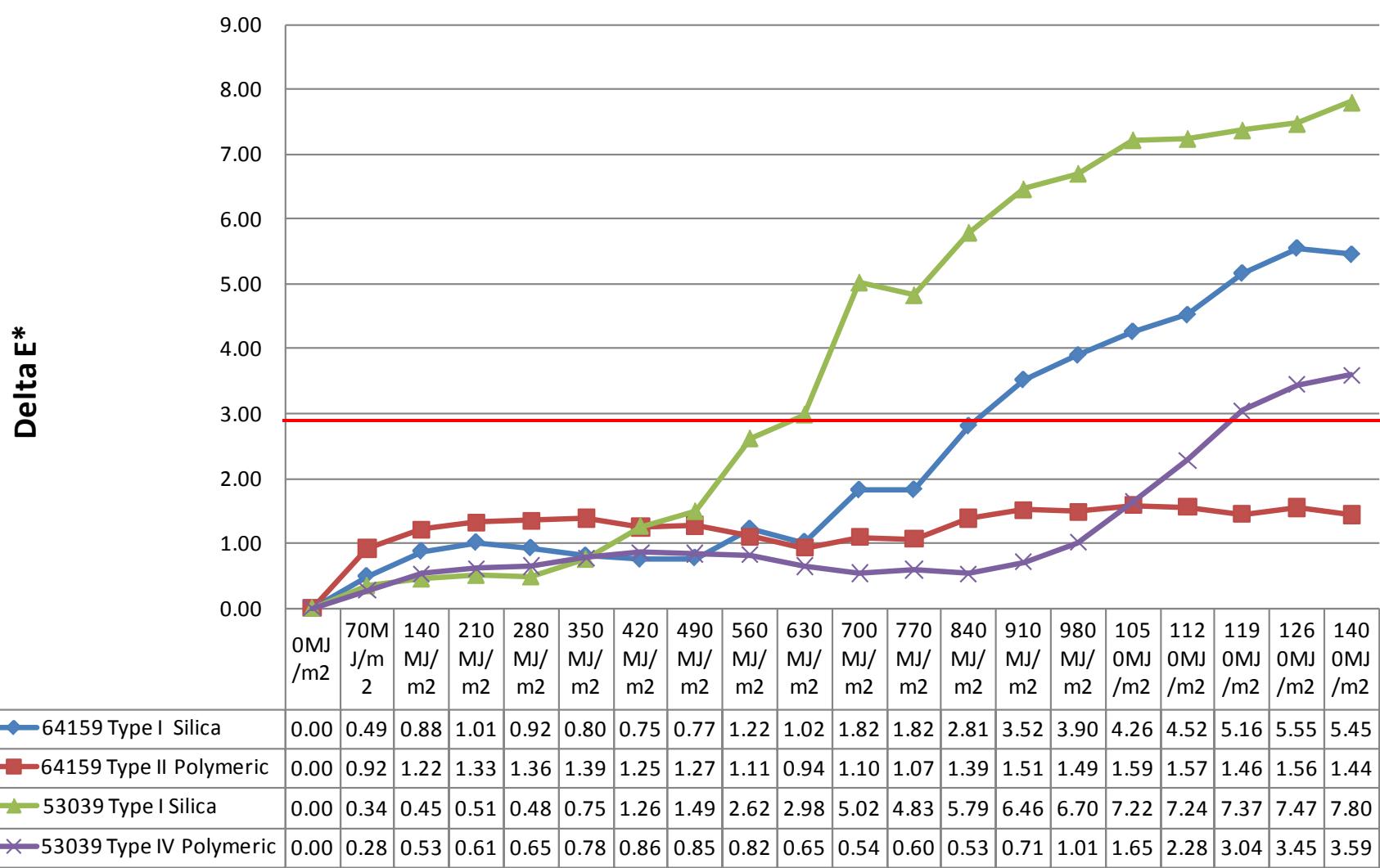
- **Polymeric beads**
  - **Reduce chalking effect**
  - **Improve UV resistance**
  - **Improve performance**



Diatomaceous silica

Talc

## Q-Lab Arizona, Accelerated Outdoor Weathering Results



- **Superior weather resistance—Minimal chalking and color degradation.**
- **Survivability—Spectral and specular reflection not affected by weathering. Infrared not affected during weathering.**
- **Superior mar resistance.**
- **Less paint weight- 20-25%**
- **Less paint usage—Documented by Star4D and Sikorsky Helicopter—10-15%. Confirmed by industry and depots.**
- **Health and safety—No crystalline silica exposure during repair, sanding and removal operations.**
- **Longer service life—less cost for repainting.**

## Raw Material Selection

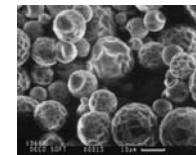
Resin



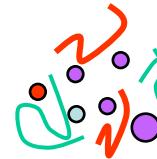
Pigments



Polymeric  
Flattening  
Agents



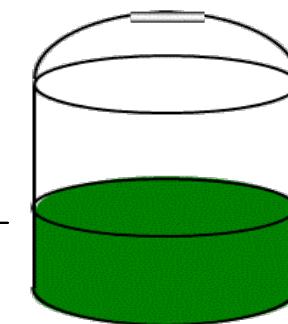
Additives



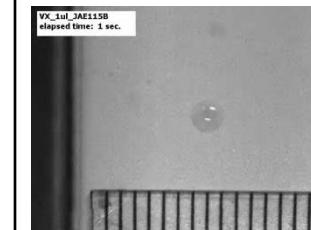
Solvents



## Tailored Coating



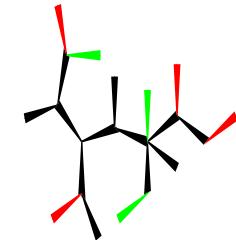
## Providing Agent Resistance



Surface Enhanced

In situ Cross-Linked

**Two Fold Approach :**  
Incorporating  
chemistries to actively  
bind and crosslink to  
create barrier  
properties and support  
decontamination  
through additional  
surface modifications

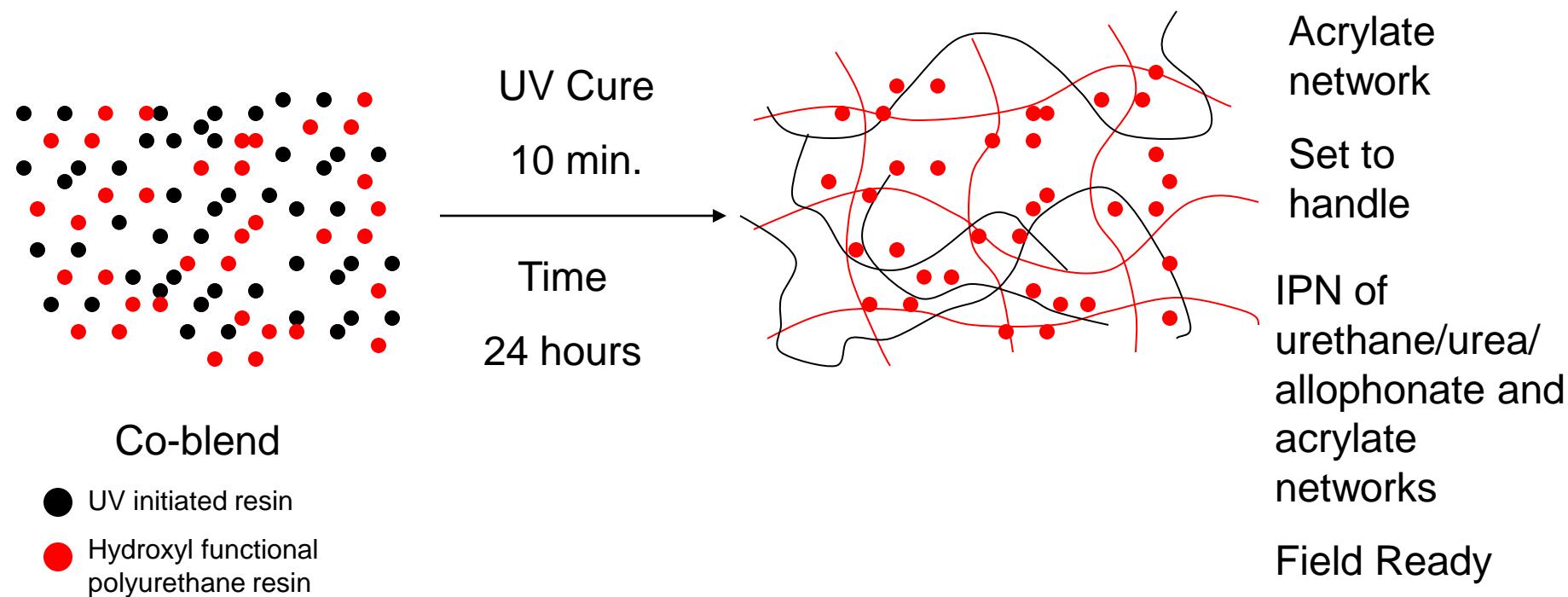


# Why UV Cure?



Reduce Dry to Fly Time

- OEM's and Depot's define production delays as a critical gap
- UV cure chemistry enables handling in 10 minutes vs. 6-8 hours (standard cure)
- Reduce VOC's
- Highly adaptable and relevant for field repairs



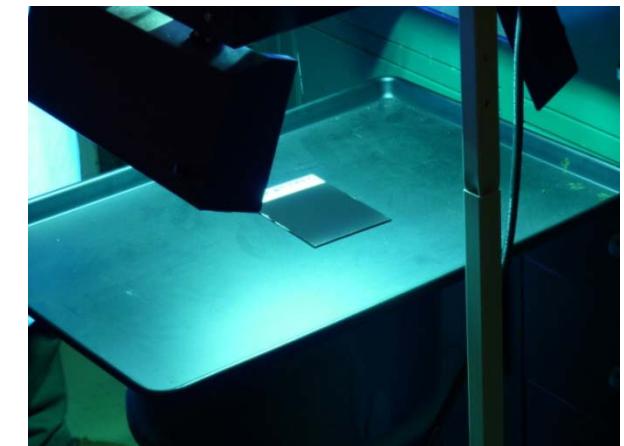
## 2K Water Dispersible Paint with UV active additives



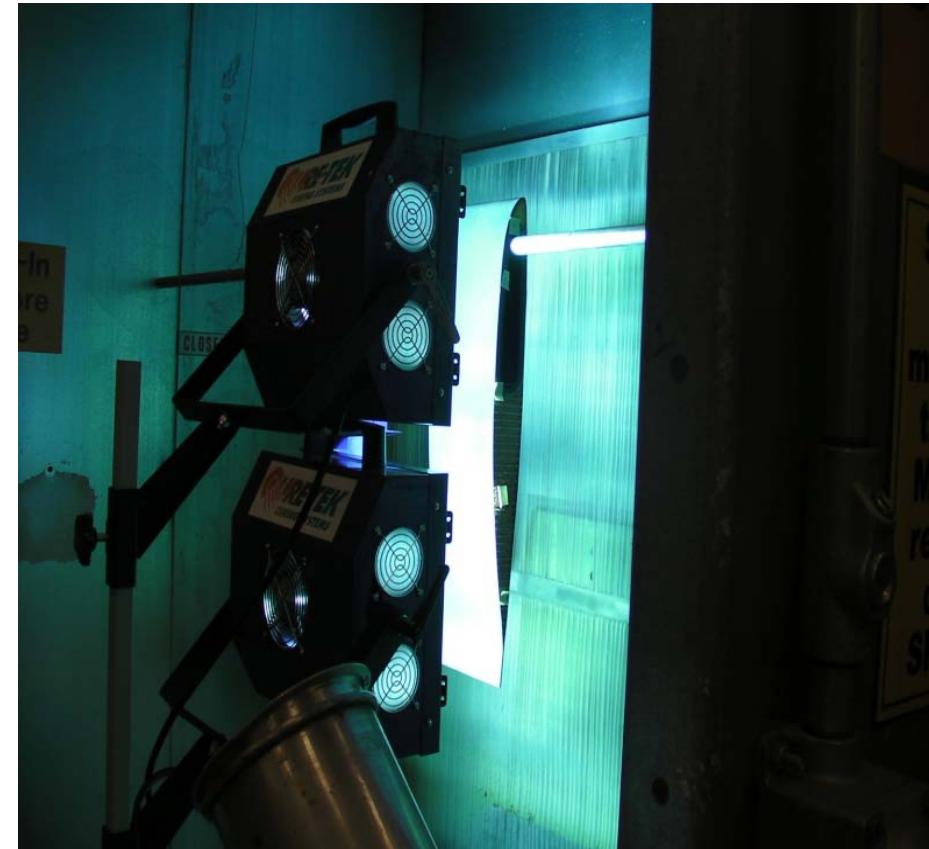
1. Mix and spray the same as MIL-DTL-64159
2. Allow 10 minute of flash off for evaporation



3. 10 minute cure process using H & S Auto Shot 1200W UVA lamp



**UH-60 rotor blade section  
coated with black rapid cure  
CARC. Cured with two  
1200W UVA lamps in  
tandem.**



- Patent Application Filed
- Formulations completed for green and black using low solar absorbing (LSA) pigmentation
- Optimized UV irradiance requirements for rapid cure (8 inch stand-off distance/ 10 minutes of UVA light exposure). Panel results show “set to handle” properties after 10 minutes following UV cure, dry hard property after 30 minutes following UV cure and MEK resistance in less than 24 hours.
- Demonstrated success of UV cure CARC on small section of UH-60 and CH-47 rotor blades.

- Technology Gaps/Accomplishments are continually evolving.
- Our successes will be with the continued collaborations with our services, industry and academia.
- Our specification and technical manuals will define the requirements and processes.
- It is within this framework that the path will be most clear and straight forward.